On Logicist Agent-Based Economics
(LABE)

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Intro to Logic-Based AI (ILBAI)
11/14/2024

Logic-&-AI In The News

So Human It's Scary: My Day Alone Talking to Bots That Sound Like Us

Joanna Stern strapped chatbots from Meta, Google, OpenAI and Microsoft to a tripod and took them to the woods to uncover the secrets of AI friendship
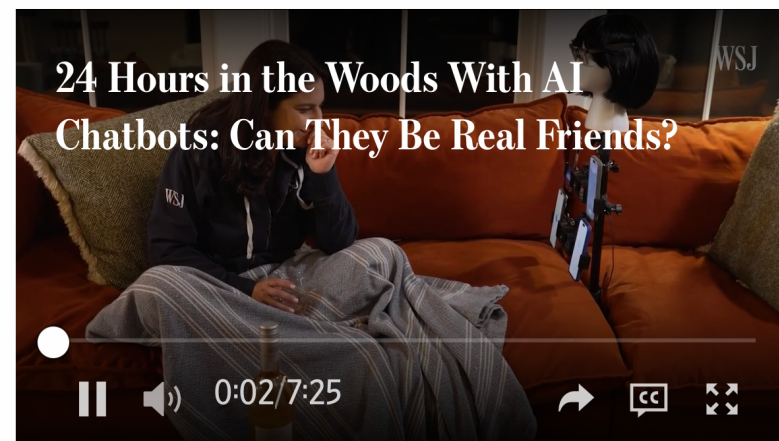
24 Hours in the Woods With AI Chatbots: Can They Be Real Friends?

0:02/7:25

Photo: Ryan Trefes/WSJ

By Joanna Stern
Updated Nov. 13, 2024 at 9:09 am ET

▶ **Listen to article** (7 minutes)

My new friends are just *hilarious*.

One suggested I de-stress by taking up knitting.

Resources/Background for LABE

- Overview lecture:

  - http://kryten.mm.rpi.edu/PRES/LABERPI040616/SBringsjord_LABE_overview.mp4

- Three Papers:

  - Deviant Bi-Pay Auctions

  - LABE & AI Counterfraud

  - LABE & Innovation (this one relates to our job coverage)

Scenario S (informal)

Suppose there are three agents, *a*, *b*, and *c*, with annual incomes of $20K, $60K, and $200K, resp. The ability of each agent on a scale of 1 (lowest) to 10 (highest) is: *a*:3; *b*:4; *c*:8. Each agent has been earning their income for each year five years running with a level of effort, during each year, of their choosing, on a scale of 1 (doing next to nothing) to 4 (an 80-hr work week). At present each agent is at level 4. The lower the effort, the lower the probability that any agent will remain employed; but here we assume a binary function from both effort and ability such that, the higher the ability, the less downward effect the function regiments for probablility of employment. Unemployment means a productivity of zero, and with lowered effort comes lower productivity as well. An unemployed agent generates no income and hence no revenue by taxation. Currently the probability that a member of the trio will remain employed is .8; this probability, again, is a function of both effort and ability. As effort declines, enjoyment from non-compensatory activity increases.

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Suddenly there arises a cost for protecting the trio from an exogenous malicious agent **D** who desires to destroy the trio and the system in which this trio live, and will likely do so unless protection is purchased. If protection is put in place, the odds of **D**'s success is zero. The levying of an income tax that annually generates funds to purchase (successful) protection from **D** on an ongoing basis can be instituted; it must generate at least $60K/yr. What do you suggest as a rational, optimal ongoing income tax system?

Some Options (informal)

Consider a few simple calculations based on three different types of income-tax systems

Lump-sum tax:
60000/3 = 20000
What do you think?

Linear/Flat Tax:
Eg 10% => 2K + 8K + 20K; insufficient.
Eg 20% => 4K + 16K + 40K = 60K; sufficient.
Is this okay? What do you think?

Progressive tax scheme:
Eg:
Above 100K: 50%
50–100: 25%
20–49: 10%
0–19: 0%
Then: 2K + 20K + 100K = 122K

How about a progression leaving: 0K, 20K, 100K?
Or why not a progression leaving: 0K, 0K, 100K?
Or for that matter: 0K, 0K, 60K?

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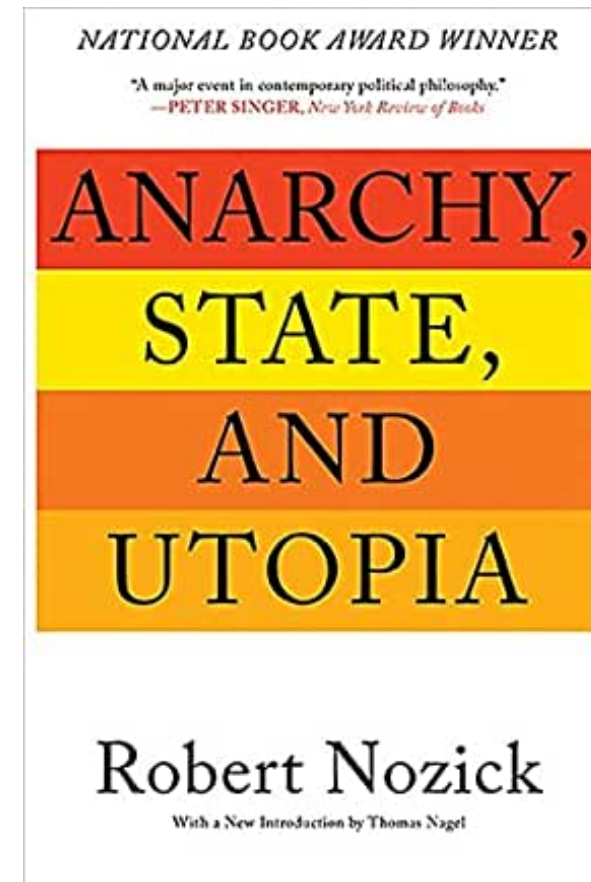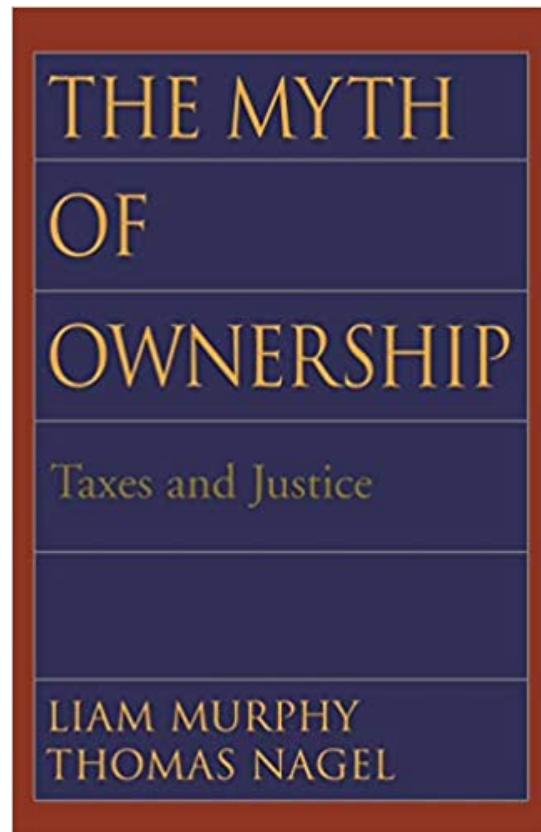Can you see a road forward to any full formalization and theorems, using formal logic?

Taxation presents problems that are AI-complete, ethics-complete, and economics-complete. ...

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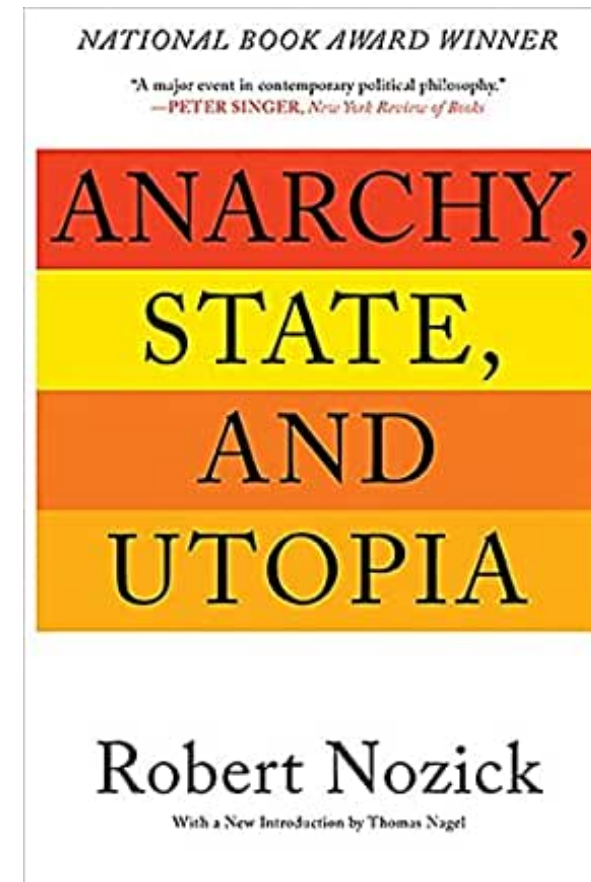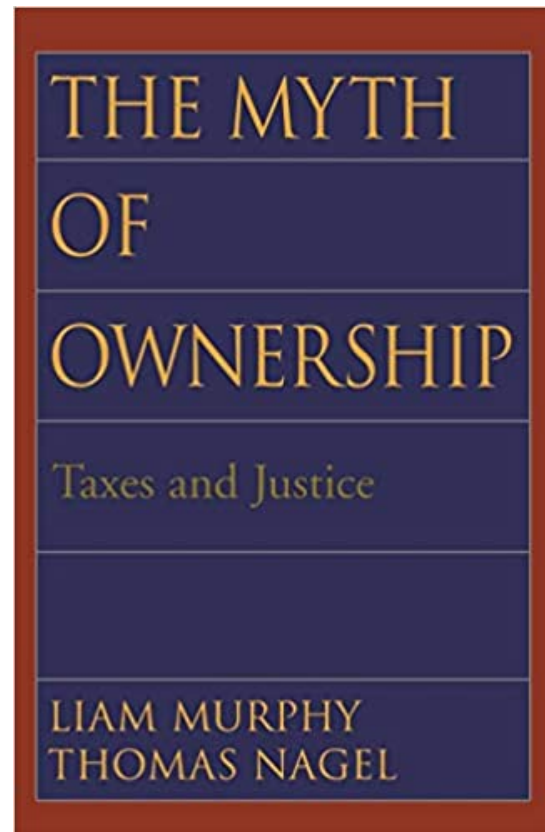So, taxation presents problems that are AI-complete, ethics-complete, and economics-complete? Really?

…

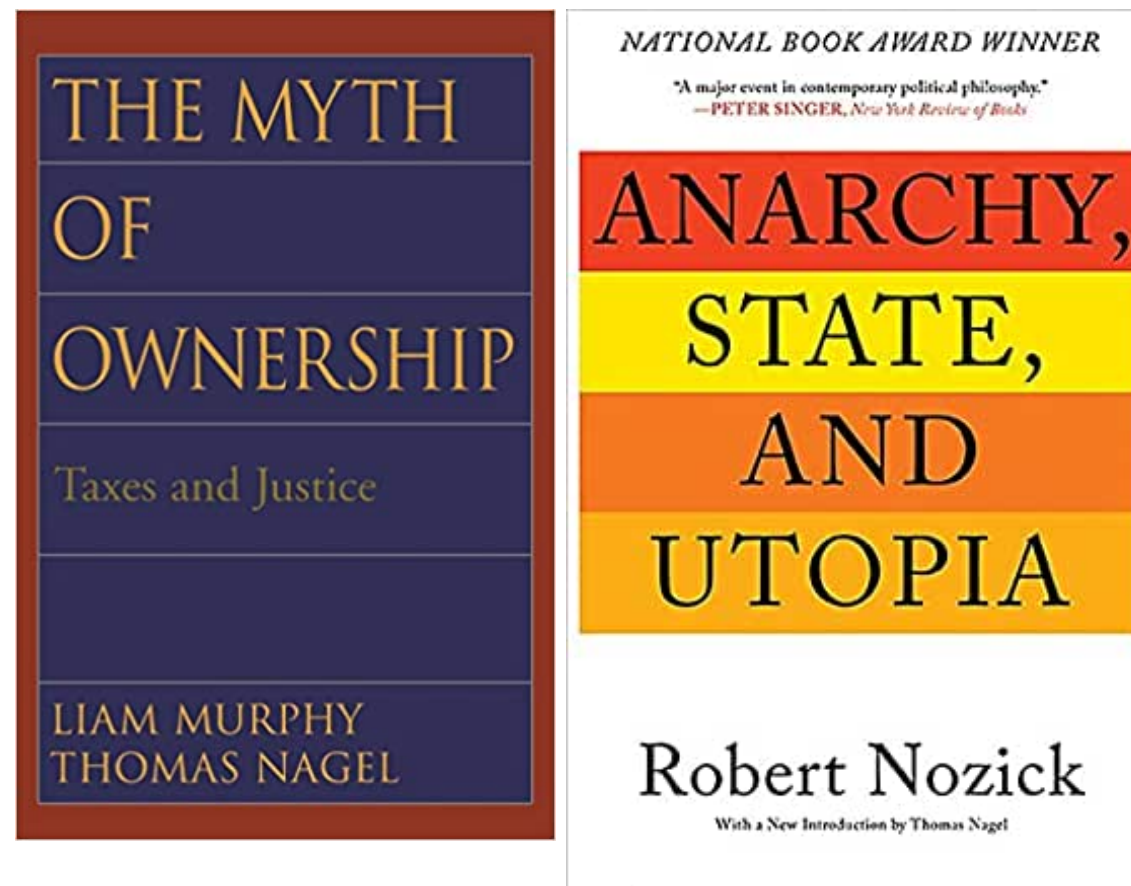# Ethics-completeness (shortcut)

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THE MYTH OF OWNERSHIP
Taxes and Justice
LIAM MURPHY
THOMAS NAGEL

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"A major event in contemporary political philosophy."
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ANARCHY, STATE, AND UTOPIA
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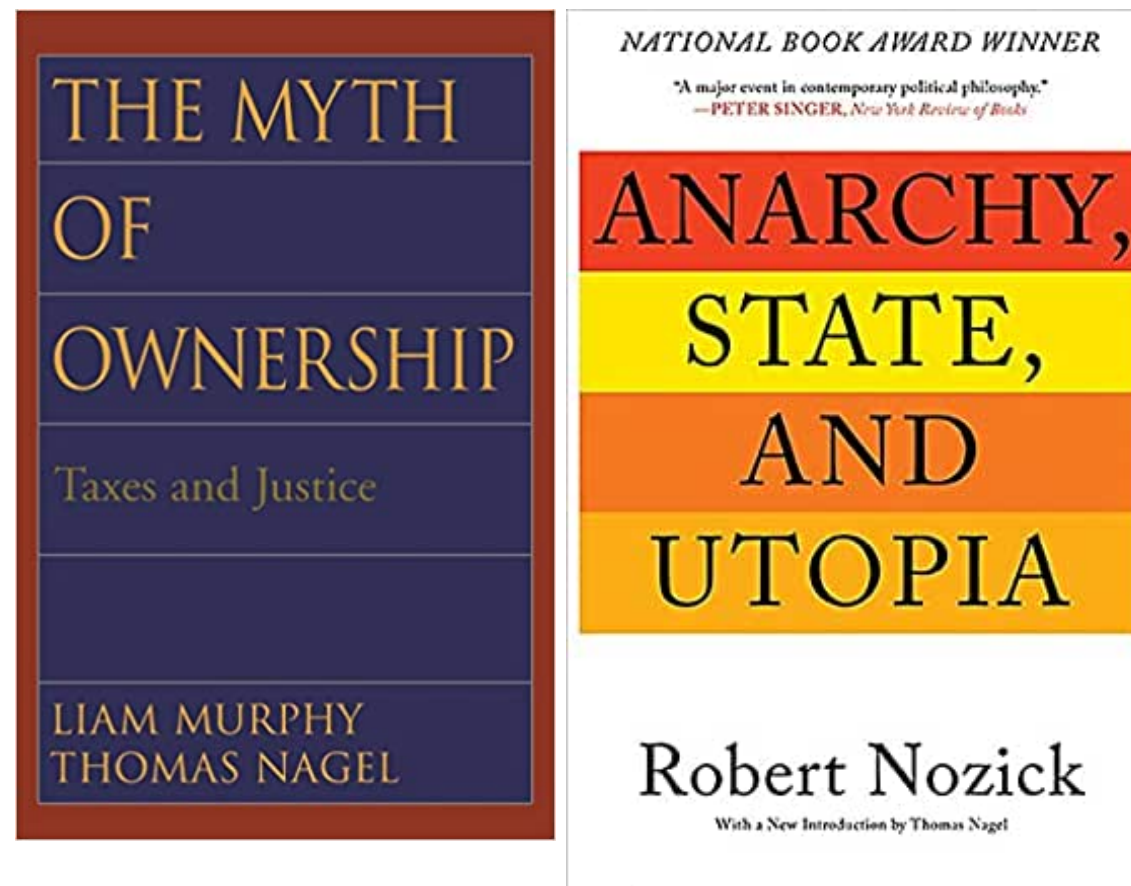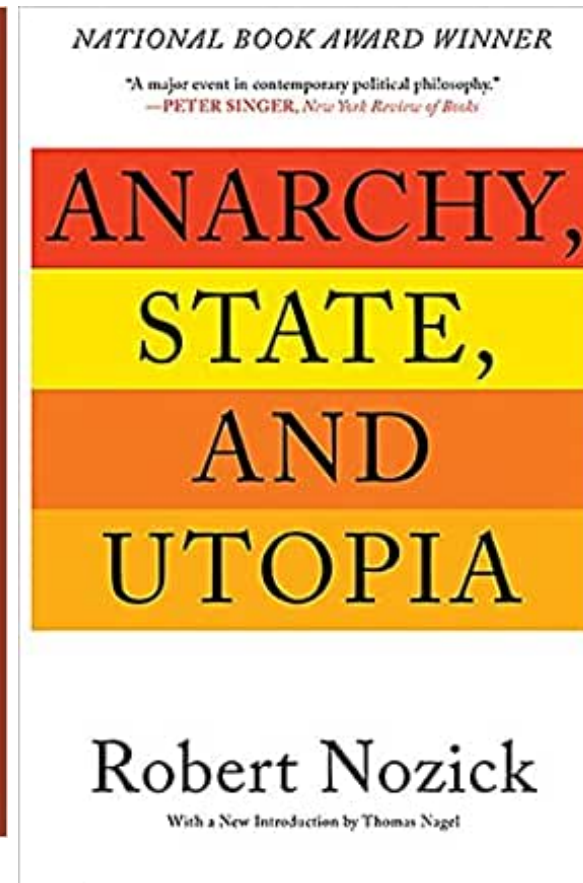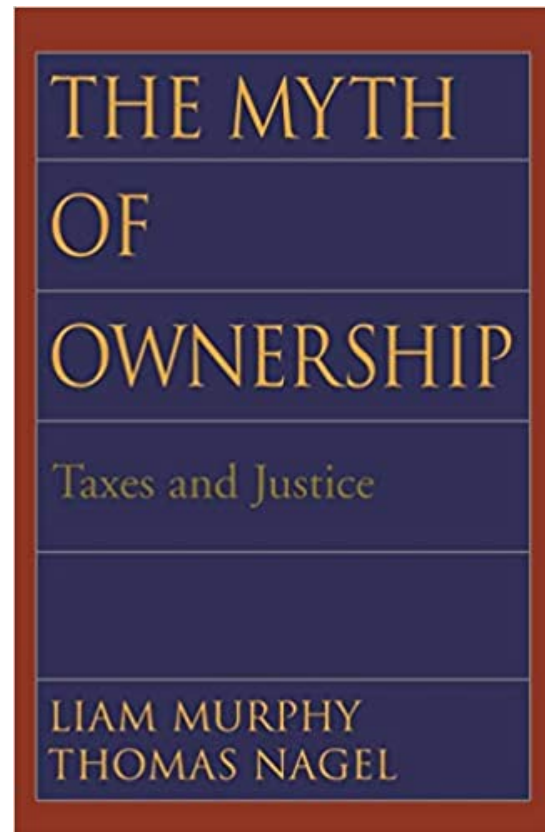With a New Introduction by Thomas Nagel

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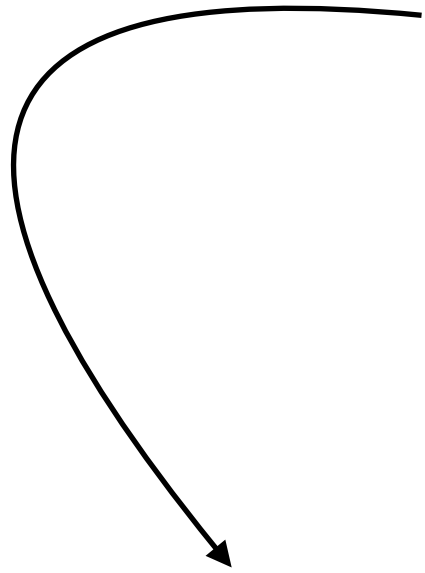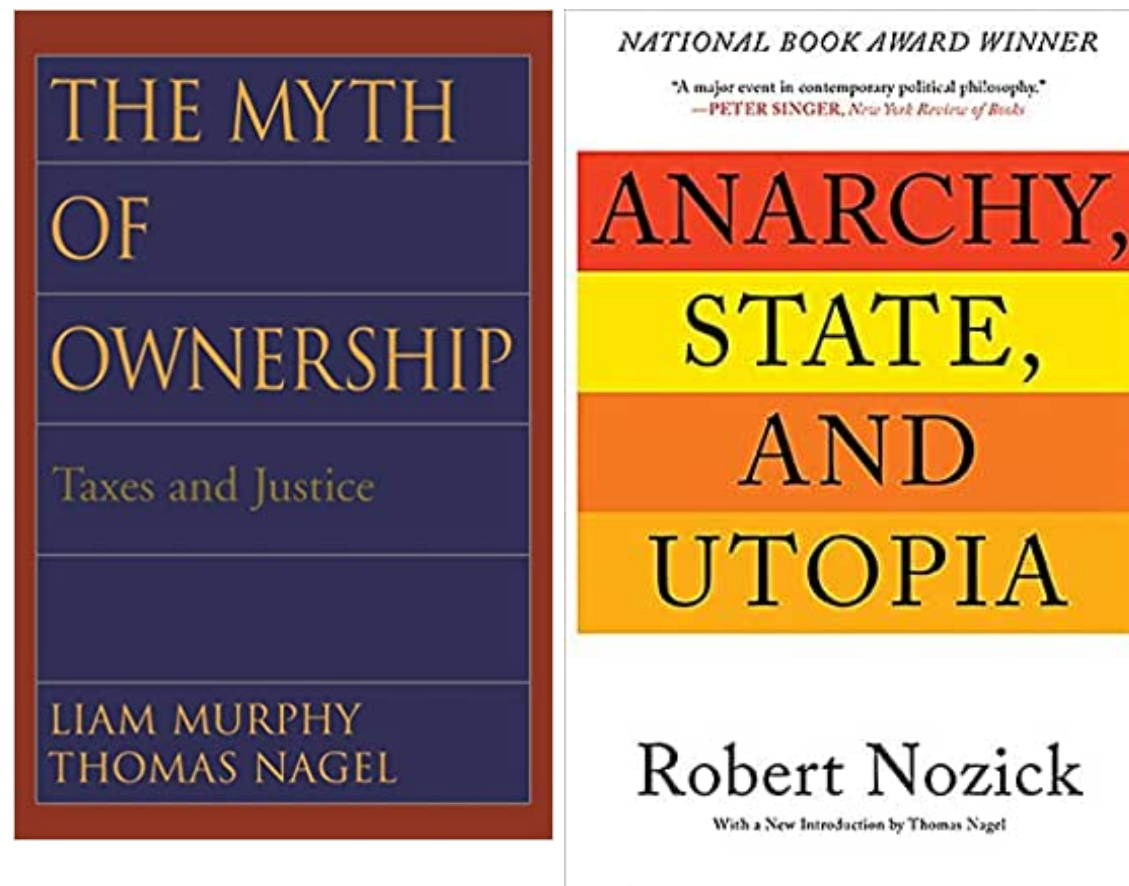# Ethics-completeness (shortcut)

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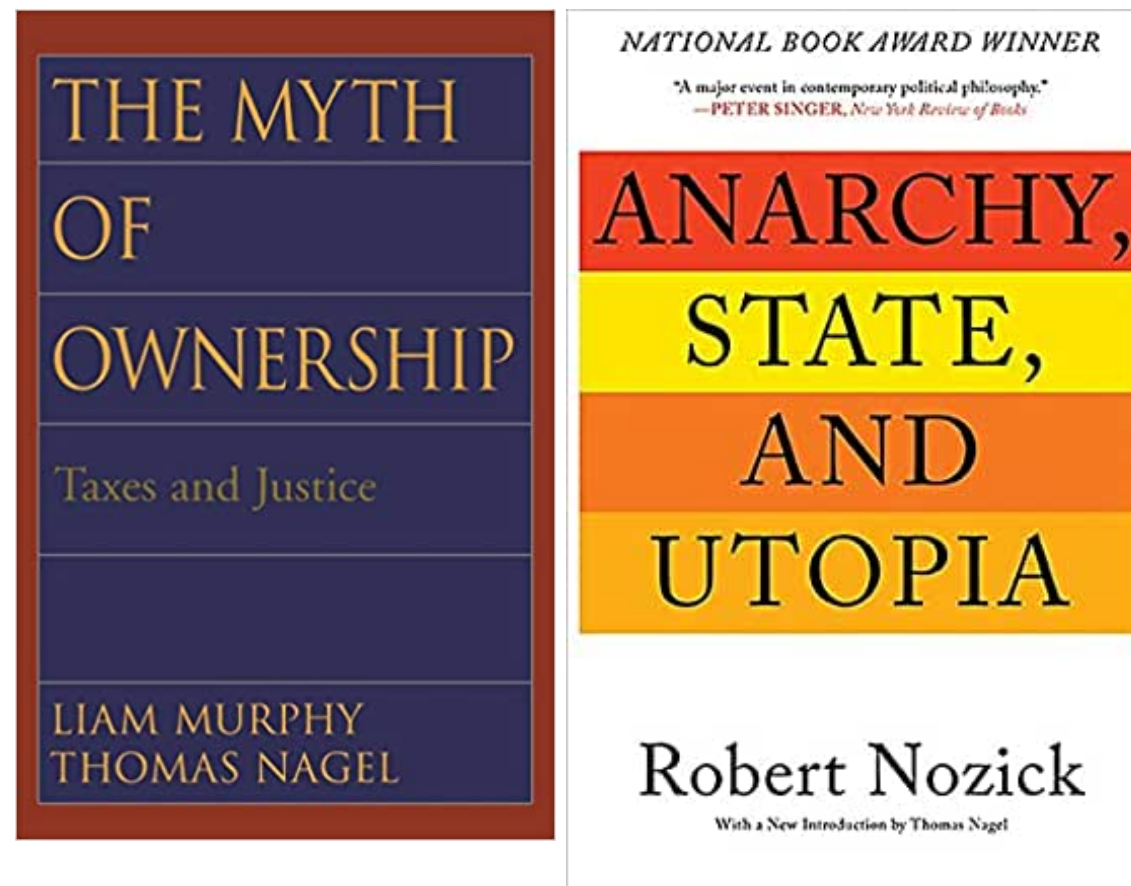
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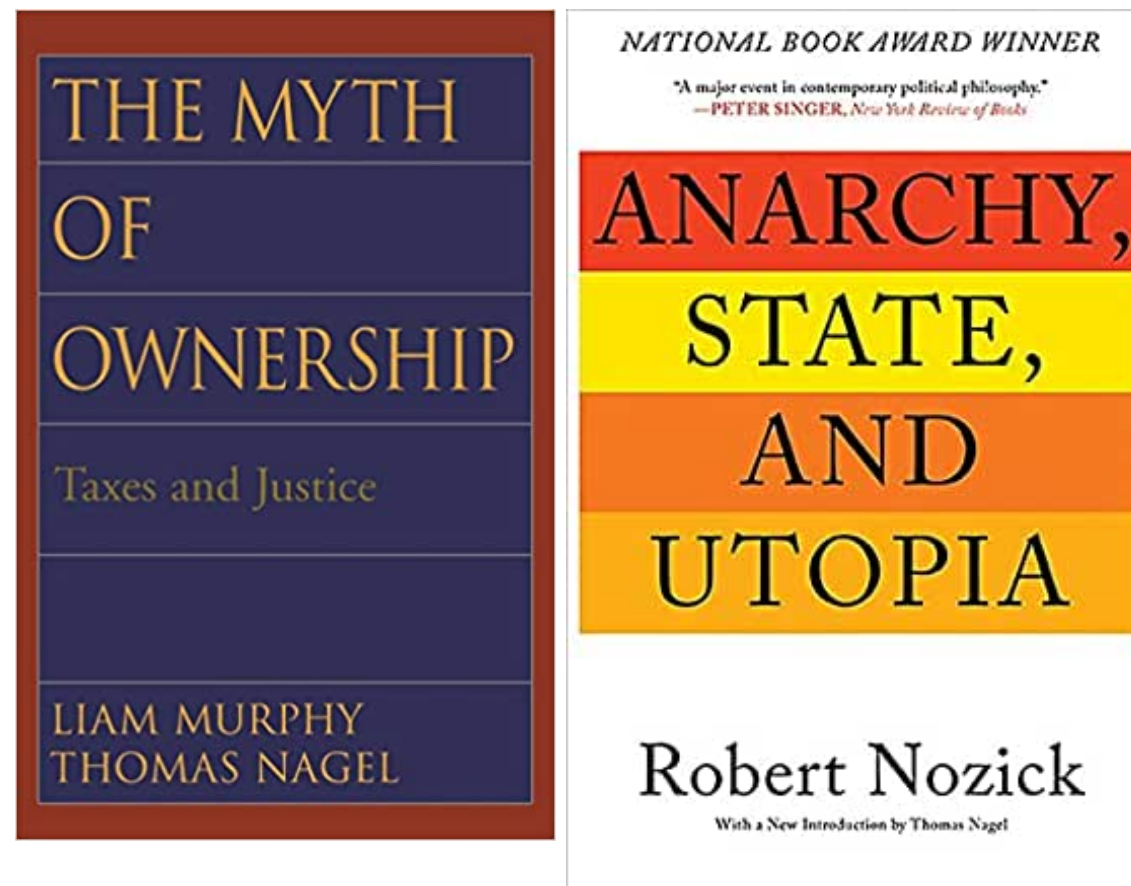Since you don't own your pre-tax income (that you do is a myth), pretty much *any* level of income tax is ethically permissible.

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Any level of taxation beyond a minimum required for Defense+ is the moral equivalent of forced labor.

But for IFLAI2 …

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The original Mirrlees argument runs as follows. Suppose there is a positive marginal tax rate on the individual earning the top income in an economy, and suppose that income is y. The positive marginal tax rate has a discouraging effect on the individual's effort, generating an efficiency cost. If the marginal tax rate on that earner was reduced to zero for any income beyond y, then the same amount of revenue would be collected and the efficiency costs would be avoided. Thus, a positive marginal tax on the top earner cannot be optimal.

—Mankiw

An Exploration in the Theory of Optimum Income Taxation[1,2]

J. A. MIRRLEES
Nuffield College, Oxford

1. INTRODUCTION

One would suppose that in any economic system where equality is valued, progressive income taxation would be an important instrument of policy. Even in a highly socialist economy, where all who work are employed by the State, the shadow price of highly skilled labour should surely be considerably greater than the disposable income actually available to the labourer. In Western Europe and America, tax rates on both high and low incomes are widely and lengthily discussed[3]: but there is virtually no relevant economic theory to appeal to, despite the importance of the tax.

Redistributive progressive taxation is usually related to a man's income (or, rather, his estimated income). One might obtain information about a man's income-earning potential from his apparent I.Q., the number of his degrees, his address, age or colour: but the natural, and one would suppose the most reliable, indicator of his income-earning potential is his income. As a result of using men's economic performance as evidence of their economic potentialities, complete equality of social marginal utilities of income ceases to be desirable, for the tax system that would bring about that result would completely discourage unpleasant work. The questions therefore arise what principles should govern an optimum income tax; what such a tax schedule would look like; and what degree of inequality would remain once it was established.

The problem seems to be a rather difficult one even in the simplest cases. In this paper, I make the following simplifying assumptions:

(1) Intertemporal problems are ignored. It is usual to levy income tax upon each year's income, with only limited possibilities of transferring one year's income to another for tax purposes. In an optimum system, one would no doubt wish to relate tax payments to the whole life pattern of income,[4] and to initial wealth; and in scheduling payments one would wish to pay attention to imperfect personal capital markets and imperfect foresight. The economy discussed below is timeless. Thus the effects of taxation on saving are ignored. One might perhaps regard the theory presented as a theory of " earned income " taxation (i.e. non-property income).

(2) Differences in tastes, in family size and composition, and in voluntary transfers, are ignored. These raise rather different kinds of problems, and it is natural to assume them away.

[3] Discussions on (usually) orthodox lines, including many important points neglected in the present paper, can be found in [7], [1], [5, Chapters 5, 7, 8], and [6, Chapters 11 and 12]. [2] is close in spirit to what is attempted here.

[4] Cf. [7, Chapter 6].

But for IFLAI2 …

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Now a battle of AI simulations
in the empirical realm?

Challenge #2:

Can the U.S. federal tax code (= IRC of 1986, as amended) by captured by some group Γ of formulae in some formal logic $\mathscr{L}$?

Challenge #3:

Can an artificial agent able to create new and effective tax strategies to minimize tax bills be engineered?

Challenge(s) #4:

Can an artificial agent automatically prove that some tax filing is illegal? Immoral? How about automatically proving that some tax code *itself* is immoral?!

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Tax Cheating
Illegal–But Is It Immoral?

Donald Morris
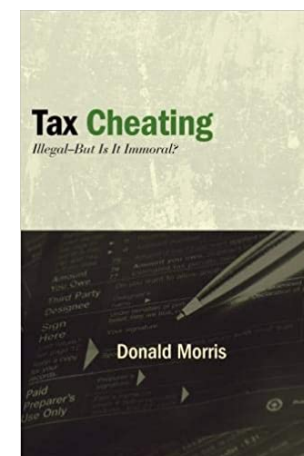
Returning now to S …

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- Paradigm: *Logicist Agent-based Economics* (LABE)

- Formalize S completely.

- Then, what theorems can be obtained re what tax frameworks are good or bad and in between?

Microsimulation

Orcutt's Vision, 50 years on

Elisa Baroni

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Matteo Richiardi

Università Politecnica delle Marche, Department of Economics, Ancona, Italy & Collegio Carlo Alberto - LABORatorio Revelli, Moncalieri, Italy.

m.g.richiardi@univpm.it.

October 2, 2007

Microsimulation

Microsimulation

Broadly defined, microsimulation is a methodology used in a large variety of scientific fields to simulate the states and behaviors of different *units* - e.g. individuals, households, firms - as they evolve in a given *environment* - a market, a state, an institution. Very often it is motivated by a policy interest, so that narrower definitions are generally provided. For instance, [Martini and Trivellato, 1997] define microsimulation models as

> computer programs that simulate aggregate and distributional effects of a policy, by implementing the provisions of the policy on a representative sample of individuals and families, and then summing up the results across individual units (p. 85).

MSM can answer relevant policy questions by handling simultaneously a large number of data, and calculating both individual and aggregate outcomes emerging from the *complex interaction* of several explanatory levels: the macro level, including e.g. demographic or labor market trends, the institutional level, including e.g. the tax and benefit system or a certain normative environment, and the micro level, including e.g. the characteristics, choices and actions of basic behavioral units such as households or firms.

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Microsimulation

2. Direct Taxation and Behavioural Microsimulation: A Review of Applications in Italy and Norway

Rolf Aaberge
Statistics Norway

Ugo Colombino
Turin University

2.1. Introduction

In this contribution we illustrate various applications of a behavioural microsimulation model that we have been developed during the last few years. Behavioural models are complex and costly tools to develop, use and maintain, but also very powerful ones as we wish to show through the examples that follow. In section 2.2 we present the main features of the microeconometric model. In section 2.3 we comment upon the labour supply elasticities implied by the estimates. In section 2.4 we illustrate a simulation of behavioural and welfare effects of some tax reform proposals. In section 2.5 we report on an exercise where we look for the optimal tax system. In section 2.6 we report on an ongoing project aimed at integrating the microeconometric model and a Computable General Equilibrium model. Lastly, in section 2.7, we show an out-of-sample test of the model, where we compare predictions of a model estimated on 1994 data to the observed effects of reform in 2001.

2.2. The microeconometric model

Over the last ten years, together with other colleagues, we have developed a structural model of labour supply[1] which features: si-

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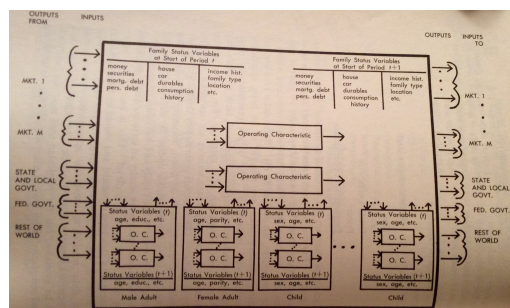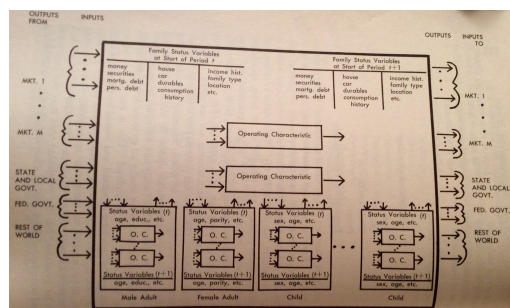
$$\max_{h,w,j} U\,(C,h,z)$$

$$s.t.$$
$$C = f\,(wh,I)$$
$$(h,w,z) \in B,$$

(2.1)

where *I* is an unearned income, *C* is a net income and *f*( ) is the tax-benefit rule that transforms gross income into net income.

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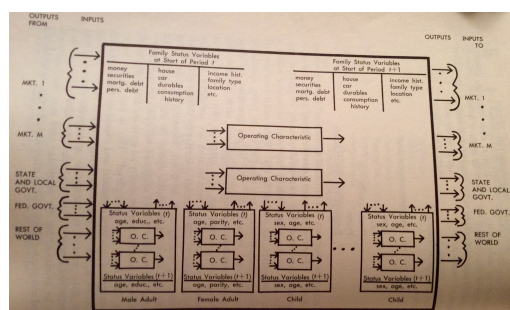
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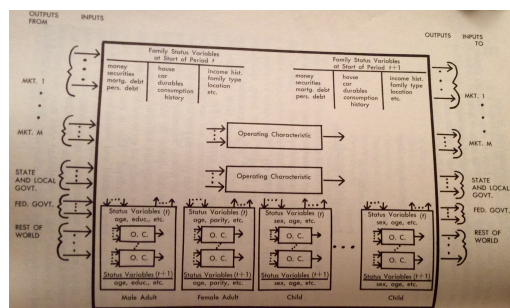

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> No emotions.

$$\max_{h,w,j} U(C,h,z)$$

$$s.t.$$

$$C = f(wh,I)$$

$$(h,w,z) \in B,$$

(2.1)

where I is an unearned income, C is a net income and $f(\ )$ is the tax-benefit rule that transforms gross income into net income.

Over the last ten years, together with other colleagues, we have developed a structural model of labour supply[1] which features: si-

[1] See for example Aaberge, Colombino and Strøm (1999), Aaberge, Colombino, Strøm and Wennemo (2000) and their references.

Microsimulation

We assume that agents choose among *jobs*, each job being defined by a wage rate *w*, hours of work *h* and other characteristics *z*. As an example of *z*, think of commuting time or the specific skills involved in the job. For expository simplicity, the text that follows considers a single person household, although the model we estimate considers both singles and married couples. The problem solved by the agent is:

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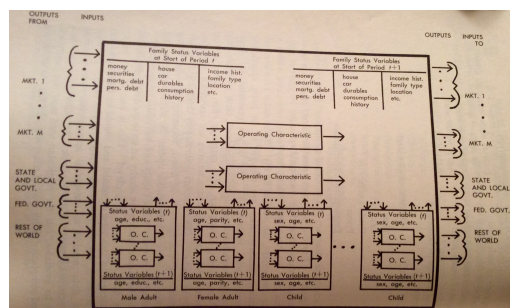No knowledge.
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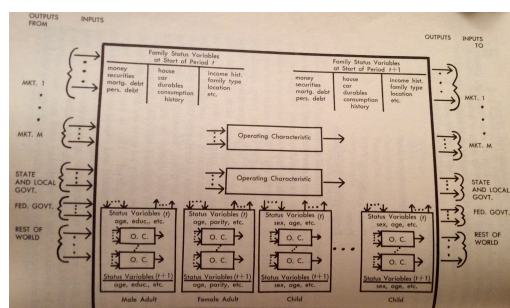No epistemic attitudes.
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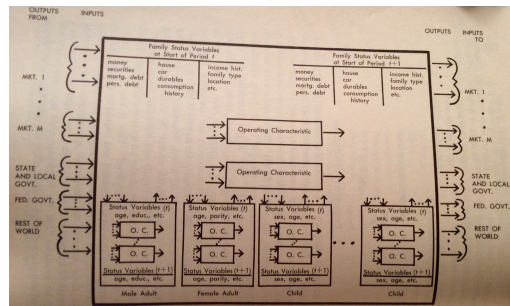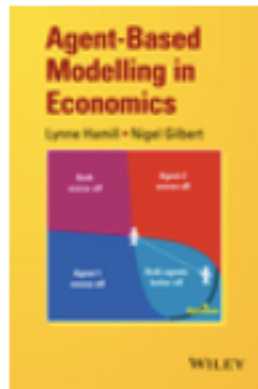
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Oh, & no communicative capacity!

$$\max_{h,w,j} U\,(C,h,z)$$

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Same Holds for Standard ABM

Agent-Based Modelling in Economics

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Lynne Hamill and Nigel Gilbert, Centre for Research in Social Simulation (CRESS), University of Surrey, UK

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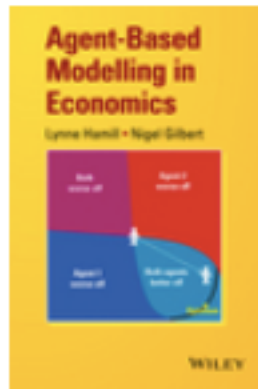Agent-based modelling in economics

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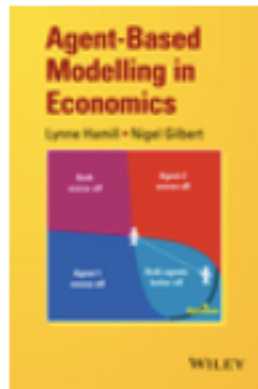
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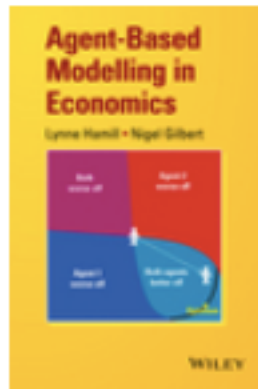No epistemic attitudes.
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Some Key Papers

Ramsey, F. (1927) "A Contribution to the Theory of Taxation" *The Economic Journal* **37.145**: 47–61.
https://eml.berkeley.edu/~saez/course131/Ramsey27.pdf

Mirrlees, J. (1971) "An Exploration in the Theory of Optimal Income Taxation" *Review of Economic Studies* **38**: 175–208.

"Optimal Taxation in Theory and Practice" by N. Gregory Mankiw, Matthew Weinzierl, and Danny Yagan.
https://scholar.harvard.edu/files/mankiw/files/optimal_taxation_in_theory.pdf

Slutten